This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LANE MEDICAL LIBRARY STANFORD
2 45 0173 6974

THE USE OF TRACTION

IN THE

TREATMENT OF CLUB-FOOT.

NEWTON M. SHAFFER, M. D.

M763
S52
1887

LANE

MEDICAL LIBRARY

LEVI COOPER LANE FUND

THE USE OF TRACTION

IN THE

TREATMENT OF CLUB-FOOT

LANE LIBRARY

WITH A CONSIDERATION OF SOME OF THE MECHANICAL POINTS INVOLVED, AND A DESCRIPTION OF THE ANTERO-POSTERIOR AND LATERAL TRACTION APPARATUS.

N.Y. Academy of Medicine LIBRARY 17 East 103rd St., New York

BY

NEWTON M. SHAFFER, M. D.

ATTENDING SURGEON IN CHARGE OF THE NEW YORK ORTHOPÆDIC DISPENSARY AND HOSPITAL

REPRINTED FROM
THE NEW YORK MEDICAL JOURNAL
FOR MARCH 5 AND 12, 1887

LANE MEDICAL LIBRARY
16535
SAN FRANCISCO

NEW YORK
D. APPLETON AND COMPANY
1887

LAME LIBRARY

M783
S52
1887

THE USE OF

TRACTION IN THE TREATMENT OF CLUB-FOOT,

*With a Consideration of some of the Mechanical Points involved, and a Description of the Antero-Posterior and Lateral Traction Apparatus.**

OVER twelve years ago I felt that there was room for improvement in the then existing forms of apparatus for the mechanical treatment of club-foot, and, in connection with my service at the New York Orthopædic Dispensary and Hospital, commenced a series of experiments bearing upon this subject, and based upon a study of the mechanism of the ankle and tarsus.

The result of these experiments was published in the "Medical Record" for November 23, 1878, under the title "Traction in the Treatment of Club-Foot." In this article, which may be called a provisional report, I called attention to some of the defects in the conventional form of club-foot apparatus, and described one form of traction apparatus, viz., the antero-posterior (see Figs. 7, 8, 9, *et seq.*), which was devised for overcoming the contractions of uncomplicated talipes equinus. The simple lateral shoe or "pusher," with its hinged lever and screw (see Fig. 22), was also de-

* Read before the New York Academy of Medicine, February 3, 1887.

scribed, the latter being used to overcome the so-called lateral deformities of equino-varus prior to the use of the antero-posterior traction apparatus.

Since the publication of this provisional paper I have continued my investigations, and have made many improvements in the apparatus first described. The antero-posterior traction-shoe has been made much more efficient, and perhaps nearly perfect. The simple "lateral pusher" did not meet all of the indications presented in the compound deformity known as equino-varus, and it has been discarded in the treatment of this condition excepting in early infancy, and then it is used as a preliminary splint, the antero-posterior or lateral traction apparatus being used subsequently.

This simple "lateral pusher," however, with its hinged lever and screw, suggested the right line of investigation and introduced, I believe, the important *pushing* principle into the mechanical treatment of talipes.* Following up the clew it gave, I have, from time to time, added other mechanical pushing and traction elements to it until I have practically perfected the lateral-traction apparatus, which meets quite perfectly the indications presented in the compound deformities of club-foot combining the elements of equinus with either varus or valgus.

In the article already referred to I ventured to point out some of the defects in the mechanism of the conventional club-foot apparatus, the principal one being the difficulty of controlling the heel, which, in the conventional form of apparatus, is held in place, more or less insecurely,

* I have searched in vain for a description of an apparatus which fulfills the indications presented by this "lateral pusher." It has a purely lateral action, the hinge being placed at or near the malleolus, and the force is applied to the concave side of the deformity, pushing the entire foot toward the normal position.

by the Scarpa heel-cup, and the retaining strap, which passes from the heel-cup over the neck of the astragalus. All surgeons who have seen and treated many cases of club-foot will at once appreciate this difficulty of controlling the heel with the apparatus ordinarily employed. I did not, when I wrote my provisional essay upon this subject, fully appreciate all the mechanical points involved, though I felt that I had discovered the correct principle of treatment. Further investigation and study enable me to present my theme in a much more tangible shape, and to accompany a description of my apparatus with, so far as I know, a few novel demonstrations of the movements at the ankle and tarsus, which movements we ought to imitate and even exaggerate with the mechanism devised to relieve the deformities of equinus and equino-varus; for it is only these varieties of club-foot that will be considered on this occasion.

I propose to call attention, first, to some points in the mechanism of the normal foot, and to afterward describe the apparatus I have devised to overcome the deformities of talipes.

In Fig. 1 let A B E represent a line drawn from the head of the fibula through the ankle joint to the sole of the foot, B representing the center of antero-posterior motion at the ankle joint. C E D represents the sole of the foot, C the heel, and D the toes. The diagram is supposed to present a side-view of the leg and foot, with the foot at right angles with the leg, as in standing upright; a position, conventionally speaking, midway between flexion and extension of the ankle joint.

In Fig. 2 we have another diagram, similarly lettered, with the ankle in extension. The line A B is the same as in Fig. 1, but at B (the center of antero-posterior motion at the ankle joint) this line becomes deflected posteriorly on its way to E, the line C E D forming an angle of about 45°

with the line A B, the position of full extension of the ankle joint.

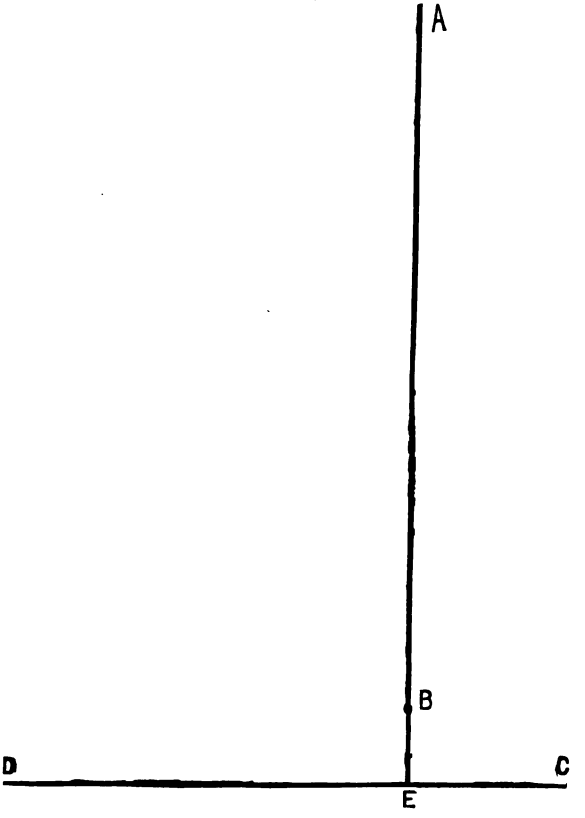

FIG. 1.

In Fig. 3 we have still another diagram, lettered as in Figs. 1 and 2, but with the ankle in full flexion. In this figure, at B, the line A B is deflected anteriorly at B on the

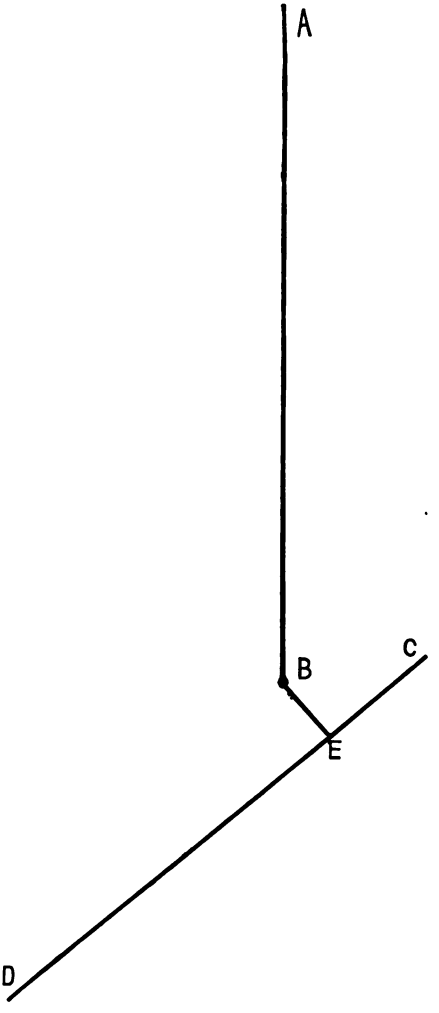

FIG. 2.

course to E, the line C E D forming, in normal flexion of the ankle joint, an angle of about 20° with the line A B.

In these three diagrams, as in the normal foot, there is only one center of antero-posterior rotation, and this is at the point B.* It is not at the ankle joint, but considerably below it, and in all our efforts to change a position of permanent extension, due to muscular or fibrous resistance, to that of flexion, we ought to construct the apparatus devised for this purpose with this definitely located center of motion properly placed. Indeed, it is well to exaggerate the force applied by placing this joint of the mechanism lower down than the normal center of motion at the ankle joint.

This center of antero-posterior rotation at the ankle joint being recognized, we will now combine these three diagrams in one and study the combination.

In Fig. 4 the vertical line A B I corresponds with A B E in Fig. 1; C I D corresponds with C E D, Fig. 1; A B K and E K F in this diagram correspond with A B E and C E D, respectively, of Fig. 2; A B L and G L H of this diagram correspond with A B E and C E D, respectively, of Fig. 3.

In short, A B K and E K F represent extension of the ankle joint. A B I and C I D represent the position when the foot is between extension and flexion, the so-called normal position, or that occupied in standing erect with the foot fairly upon the floor. A B L and G L H represent extreme flexion. All of these three positions have one common center of antero-posterior rotation, viz., B, just

* "The axis of rotation of the curved superior surface of the astragalus passes through the most fixed part of the bone, viz., the tarsal canal, touching the outer malleolus, but passing below the inner, which does not descend so low."—Frank Baker, in Wood's "Handbook of the Medical Sciences," article "Ankle Joint."

as there is only one center of antero-posterior rotation at the ankle joint.

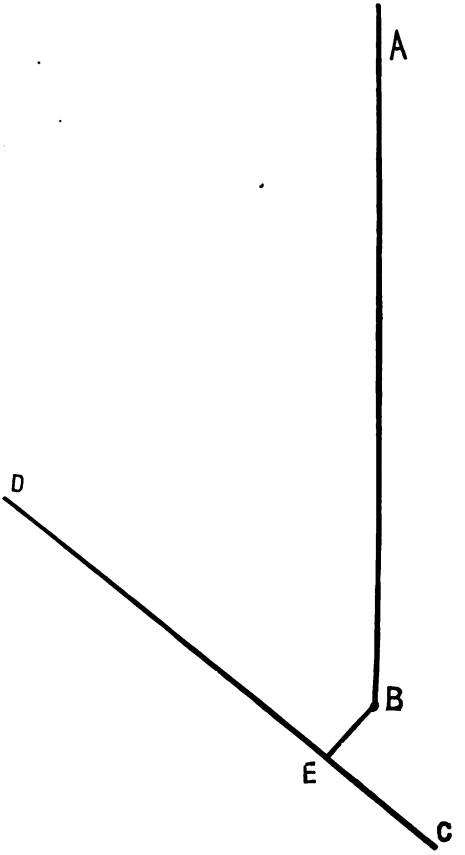

FIG. 3.

We may now apply the principle demonstrated by these diagrams to the deformity of talipes equinus. The ankle

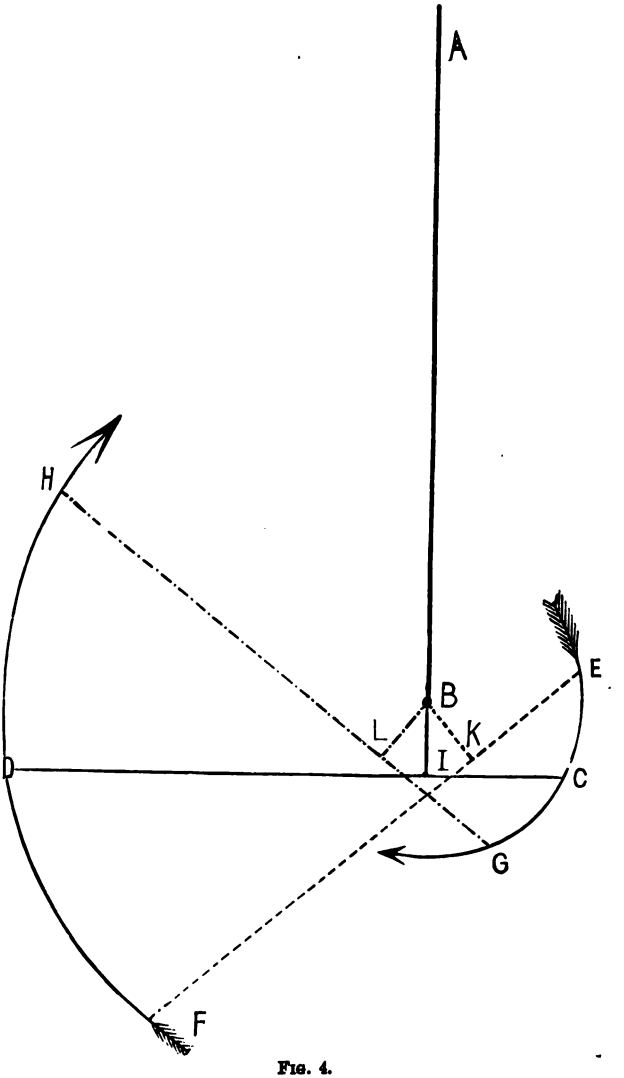

Fig. 4.

is in, we will suppose, full extension, and the heel is represented by the letter E, in Fig. 4. The problem is to force the heel, E, to take the position G, and to carry the toes from the position F to that of H. The heel, rotating around its center of motion B, must follow the curved arrow E C G, and the toes must also follow the curved arrow F D H.

It naturally follows that the arrows E C G and F D H represent segments of a circle, each having a common center B, the latter having a longer radius.

This fundamental position being recognized, we can now study the direction of the curved heel and toe arrows, and attempt to apply the results of our study to the antero-posterior deformity known as talipes equinus.

Taking the point opposite the center of motion, B, as the plane of measurement, the direction of the heel arrow is *downward* and *forward.* Taking the same center and plane again, the direction of the toe arrow is *upward* and *forward.* When the right-angled position is reached, the heel arrow still goes *downward* and *forward*, being carried below the plane of the standing position, and the toe arrow has a direction *upward* and *backward*, or toward the vertical line (A B, Fig. 4), as in normal flexion of the foot.*

Any apparatus devised for the relief of the conditions found in talipes equinus ought to carry out these indications, and present movements based upon a correct interpretation of normal antero-posterior ankle-joint rotation.

It may be said that the conventional forms of club-foot

* When the "right-angled position" (Fig. 1) is reached in overcoming the deformity of talipes equinus, the deformity is practically reduced. The antero-posterior traction-shoe is so arranged, however, that any desired position of flexion may be obtained, the traction-bar being made long enough to forcibly carry the heel *downward* and *forward* to any desired extent, thus forcing the toes *upward* and *backward* toward the tibia when the "right-angled position" is passed.

apparatus present the movements here described. Many of them do, but no adequate means is taken to make the deformed foot, restrained by muscular contraction, follow the direction taken by the curved arrows; and, for reasons now to be stated, they can not be made to accomplish this end.

As I stated in the paper already referred to, when criticising the conventional method of retaining the heel in the heel-cup of the ordinary forms of apparatus devised for the treatment of club-foot, "the point at which the retaining force and counter-pressure is made" (the neck of the astragalus) "must also rotate around the pivotal point" (the center of motion indicated by B in all the foregoing diagrams).

In Fig. 5 let A represent the center of motion at the ankle joint. A H represents extension of the ankle joint; A I, the right-angled position; A J, flexion. When the heel rotates around the center of motion, A, and goes *downward* and *forward* (curved arrow B C), the toes pass *upward* and *forward* (curved arrow F G), the neck of the astragalus passes from H^1 (extension) to I^1 (right-angled position) to J^1 (flexion), and it (the neck of the astragalus) follows its own curved arrow, D E, the direction of which is *upward* and *backward*. In short, the heel rotates *downward*, and the neck of the astragalus rotates *upward* around the transverse center of antero-posterior motion at the ankle joint.

It becomes plain, therefore, that the neck of the astragalus, being tied down, as in the conventional form of apparatus, can not rotate *upward*, and, if this movement is blocked, the heel can not go *downward*. When flexion is attempted in the ordinary forms of apparatus, with the retaining heel-strap applied, there are these insurmountable mechanical impediments that effectually prevent the foot from following the mechanical law of antero-posterior rotation which I have attempted to describe.

If this heel-strap which passes over the neck of the astragalus is loosened to permit the movements indicated in the conventional form of apparatus, all control over the foot is lost.

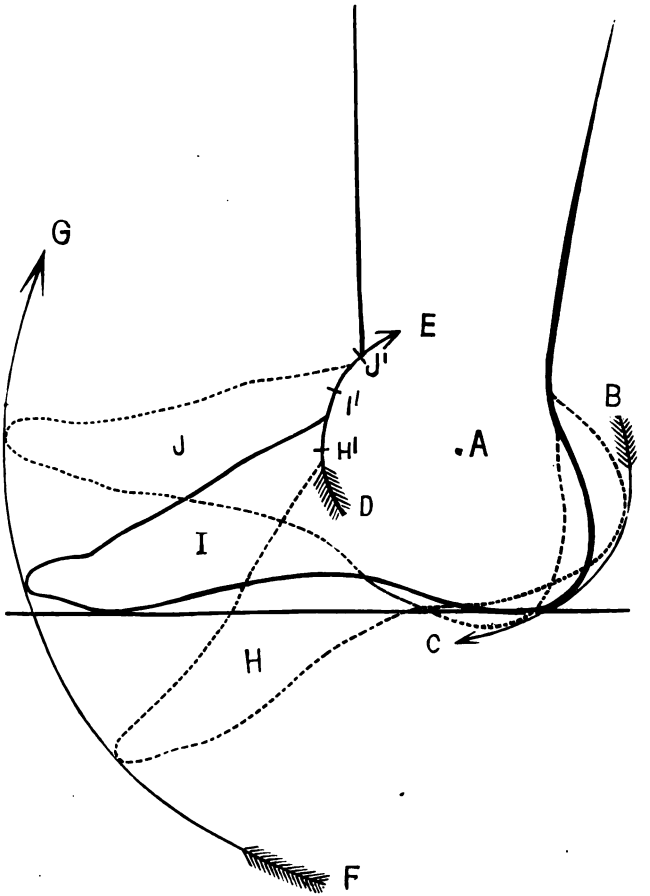

FIG. 5.

And this brings us to an important point that ought to be considered. The center of motion of the ankle joint is below the malleoli. While this anatomical center of antero-posterior rotation of the ankle can not be changed, and we can make the artificial center in the apparatus correspond with it, the restraining force necessary to produce forcible flexion of the ankle must be applied at the *rotating astragalar neck.* If we could pass an iron bar transversely through the foot at the center of antero-posterior motion of the ankle, the restraining astragalus strap would be unnecessary. Even if this could be done, the foot would not follow the apparatus with strong contractions holding it in a deformed position unless the foot were securely fastened to the foot-plate of the apparatus by some such means as the traction heel-strap of my apparatus (soon to be described), and an adequate force applied to bring the foot into the desired position. It should be remembered that we are not, in treating the conditions found in club-foot, applying a mechanism to a foot with normal antero-posterior motion. There are strong contractions to be overcome, and the normal movements should be *exaggerated*, in order to exert the proper *traction* upon the resisting tissues.

In the conventional form of club-foot shoe the rotation of the astragalus is blocked by the faulty mechanism, antero-posterior rotation of the ankle joint is prevented, the heel is not controlled by the Scarpa heel-cup, and no adequate force is applied to carry the heel *downward* and *forward.*

There is another fault no less important in the mechanism of the ordinary form of apparatus.

I will attempt to explain it by another diagram:

In Fig. 6, A B I and C I D correspond with A B E and C E D of Fig. 1 when the foot is at the right-angled position. A B K and E K F correspond with A B E and C E D of Fig. 2 when the foot is in extension. In the conventional form

of apparatus the flexion force is applied in the direction of the arrow, R S, which is mechanically incorrect and opposed to the movements sought for. The heel should move *down-*

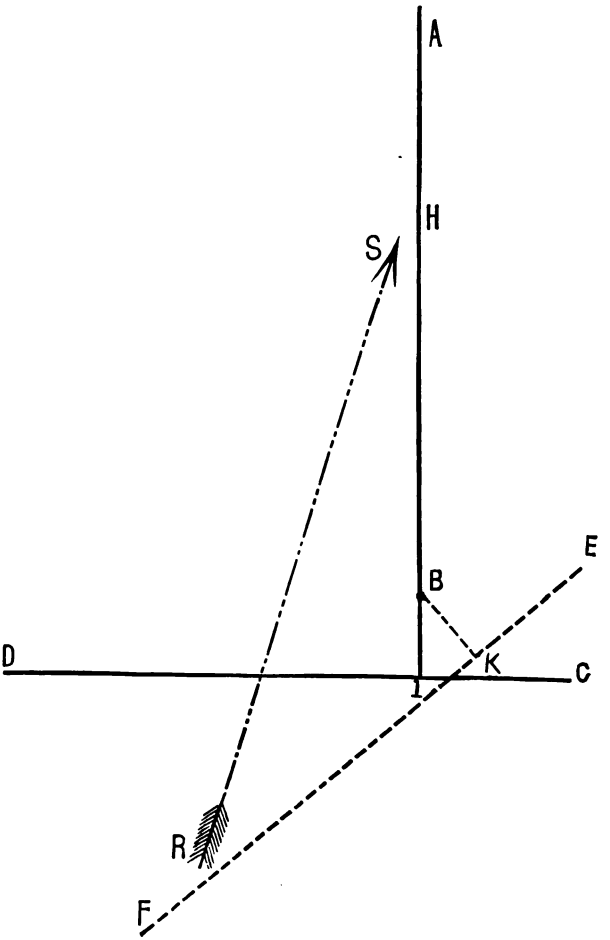

FIG. 6.

ward and *forward*, the toes should go *upward* and *forward*, the head and neck of the astragalus should pass *upward* and *backward*, in the first movement of talipes equinus. Any force, be it elastic or otherwise, applied in the direction of the arrow, R S, in talipes equinus, antagonizes these movements, and favors the *upward* and *backward* movement of the heel, especially if a restraining astragalar strap is used to block the upward rotation of the astragalus. When the right-angled position of the foot is reached, the movement indicated by the arrow, R S, is correct, if the heel is brought downward and forward by some traction force, and allowance is made for the rotating astragalar neck. But when the right-angled position is reached, the difficult feature of the deformity is removed, and the favorable result is practically assured.

Still another fault exists in the conventional form of apparatus. No provision is made in the foot-plate of the apparatus for the heel as it passes *downward* and *forward*. As soon as the right-angled position is passed, the heel drops below, just as the toes pass above, the plane presented by the sole of the foot as it rests upon the floor. This is shown in the curved heel arrows in Figs. 4 and 5. As soon as the right-angled position is passed, the further rotation of the heel is permanently obstructed in the conventional form of apparatus by the foot-plate of the apparatus, which should be provided with an opening for the descending heel.

It should be the object of treatment in talipes equinus to restore the normal movements of the ankle, if possible; certainly to produce a certain amount of flexion beyond the right-angled position. The apparatus about to be described permits any desired angle of flexion to be obtained, and the apparatus is especially constructed with this end in view.

These are the principal points of criticism to be made

upon the conventional forms of apparatus obtainable in the shops of the instrument-makers. There are others I might urge were there time or inclination. Those mentioned are the most important, and demand the attention of all who are interested in the treatment of club-foot.

Having pointed out that which I consider radically defective in the apparatus ordinarily used for the treatment of club-foot, and which I was taught to use and did use for years, I come now to a description of what I have termed the "traction apparatus," which, I think, not only meets the mechanical indications mentioned, but permits the application of sufficient force to overcome many of the deformities presented without the intervention of tenotomy.

As the diagrams I have presented bear only or principally upon the indications for the treatment of antero-posterior deformities, with plantar or post-tibial contraction, or both, I will describe the "antero-posterior traction apparatus" first, and call attention to the "lateral-traction shoe" afterward.

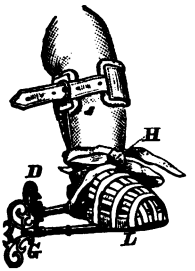

FIG. 7.

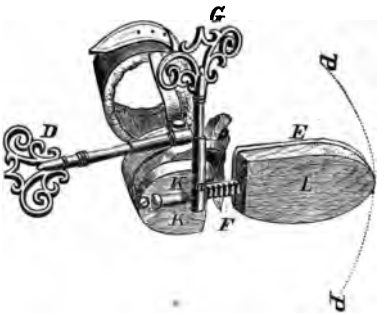

FIG. 8.

In the paper already referred to I described this antero-posterior traction-shoe. I then attached the apparatus to the foot by means of adhesive plaster. The apparatus with its

adhesive-plaster attachment, as originally used, is shown in Fig. 7.

Figs. 8 and 9 were also used to illustrate the apparatus.

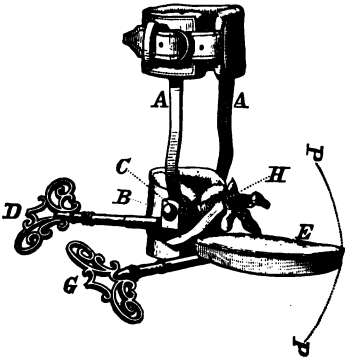

FIG. 9.

I have long since discarded the use of adhesive plaster in making traction for a much more ready and convenient method, as will be seen by a comparison of these engravings with the engravings that illustrate the apparatus as used at present.

The apparatus as at present used, without the webbing heel-traction strap (by which traction is made), is shown in Fig. 10. It consists of a calf band joined to two strong uprights, which are attached, opposite or below the center of ankle-joint motion, to the heel-cup. These parts, being very prominent and easily understood, have not been lettered. This heel-cup * is perforated posteriorly, as in the conven-

* This heel-cup is an unnecessary adjunct to any club-foot shoe which aims to bring the heel downward and forward. I have recently had my apparatus made without any heel-cup. It serves, however, as a useful guide in placing the heel in position before applying traction,

tional form of apparatus, by two openings, H, through which the heel-strap, or, as I prefer to call it, the astragalus retention-strap, is passed (see C, Fig. 16). One upright (see Fig.

FIG. 10.

12, C D) is attached to the heel-cup by an endless worm and screw, controlled by the key A (Fig. 10); the other upright has a plain antero-posterior joint, F, seen in the engraving. This endless worm and screw movement enables the operator to place the foot-plate of the apparatus at any desired angle of flexion or extension. At a point which corresponds,

and strengthens the apparatus. But the Scarpa heel-cup is unnecessary, inasmuch as the first movement of the heel is *forward* and *downward*,

when the apparatus is applied, with the medio-tarsal joint, the foot-plate is divided transversely and the anterior part is connected with the heel portion by a traction rod, B, which is controlled by a key C. Under the heel-cup is a long cylinder, I, into which the traction bar fits, and the foot-plate is extended posteriorly to afford a strong support (G) for the traction-cylinder and rod. Anteriorly the foot-plate has on its lower surface two buckles, E, for the attachment of the traction heel-strap (Fig. 14; Fig. 15; K and D D, Fig. 16). This heel traction-strap is made of webbing. It goes around the heel, and, passing forward, is reflected back upon the uprights of the bridge, D, to the buckles at E, on either side of the under part of the foot-plate (see Figs. 15 and 16). The key C moves the anterior part of the foot-plate backward and forward by a ratchet movement on the extension bar, B.

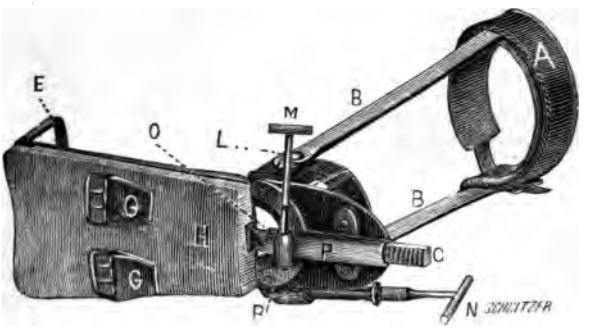

Fig. 11.

Fig. 11 gives a view of the lower part of the foot-plate. The buckles, G G, for the attachment of the traction heel-strap; the traction rod, C; the cylinder, P; the flexion and extension worm and screw controlled by the key, N, are plainly shown. The key, M, is in position to throw the anterior part of the foot-piece forward. The semicir-

cular opening, O, for the descent of the heel, in the foot part of the heel-cup, surrounded by its strong rim, R, is also shown. When traction is made and the heel is brought downward and forward, it passes through this opening unopposed by any obstruction.

Fig. 12 shows another view of the apparatus. The endless screw is shown at C and D; the heel-cup at E, with the two openings, M M, for the astragalus retention-strap; the semicircular opening, O, for the descending heel, and the bridge, F, for the reflected heel traction-strap.

Fig. 12.

Fig. 13 affords a general view of the apparatus with the traction rod closed and with the heel, toe, and astragalar arrows in position, all having their center in the ankle joint, C, of the apparatus.

This being a brief description of the antero-posterior traction apparatus, I will now attempt to show its application and to demonstrate how it fulfills the indications I have tried to point out.

The first step in the application of the apparatus is to prepare the foot for the traction it must undergo, and to so apply the necessary pads and straps that the movements indicated in the previous part of my remarks may be accomplished.

This preliminary process is shown in Fig. 14. A thick pad of Canton flannel or other soft material, C, is placed over the neck of the astragalus. A narrow piece of roller bandage, A, is then passed over it and around the heel as indicated in the engraving. Two or three turns are sufficient. The end of the bandage is secured by an ordinary pin just below the internal malleolus, where no pressure is exerted

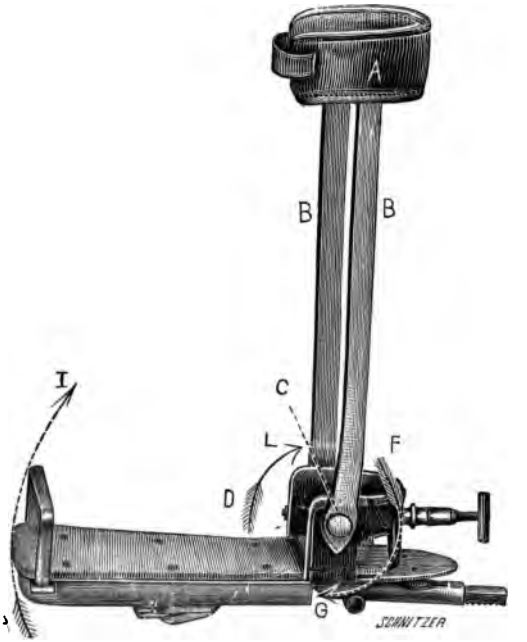

FIG. 13.

when the traction is applied. A piece of surgical webbing five eighths of an inch wide is then placed over the heel, well down, and brought forward under the bandage and below the malleoli (as shown in Fig. 14), the bandage act-

ing not only to retain the astragalar pad in position, but the heel traction-strap as well.* (In the engraving the webbing

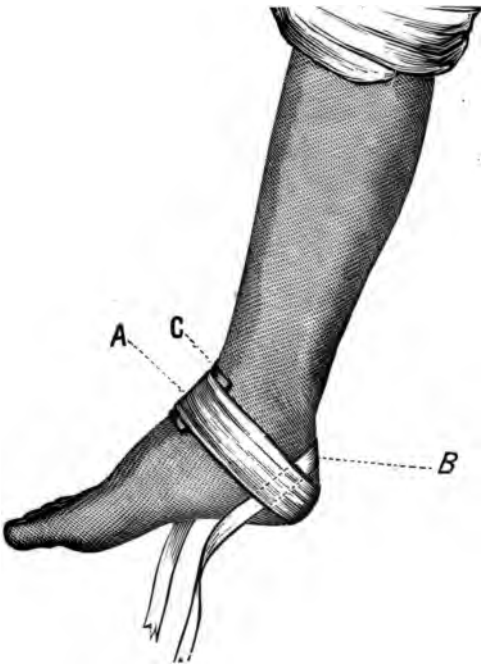

FIG. 14.

heel traction-strap is much too short, and the pad, C, should be much thicker.)

In Fig. 15 the traction heel-strap is shown (D D and K). This is the correct position for it when the traction is applied, though it is here shown lying against the heel-cup at K,

* As this webbing is an important matter, I may say that the only webbing I have obtained which answers the purpose came from Messrs. H. V. Allien & Co., No. 738 Broadway, New York.

without being passed under the retaining bandage, as in Fig. 14. It is carried forward to the uprights of the bridge and is reflected back at O, to pass, as in J (Fig. 16), to the buckles underneath the foot-plate.

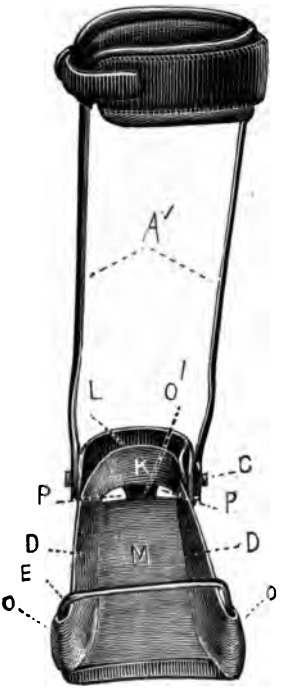

FIG. 15.

In Fig. 16 the astragalus and heel traction-straps are shown in position, the general adjustment being illustrated in Figs. 17, 18, and 19. The astragalus-strap, C, is made of Allien's webbing, five eighths of an inch wide, seventeen or eighteen inches long, and a buckle is sewed on one of its free ends, as at D (Fig. 16). This webbing is passed through the openings in the upright part of the heel-cup (M M, Fig. 12), and is "buckled on itself," as shown in the engraving. The traction heel-strap is also shown (H J), though, of course, this strap is passed around the heel and under the retaining bandage as a preliminary step, as shown in Fig. 14.

I have made it a cardinal rule in the treatment of chronic deformities *to make the apparatus fit the deformity*, and to so arrange the mechanism of the apparatus that a progressive and easily applied pressure may be exerted in the direction indicated. This is especially true of the mechanical treatment of club-foot, and I have long since ceased to at-

tempt to crowd a crooked foot, partly relieved by tenotomy, into, comparatively speaking, a straight apparatus.

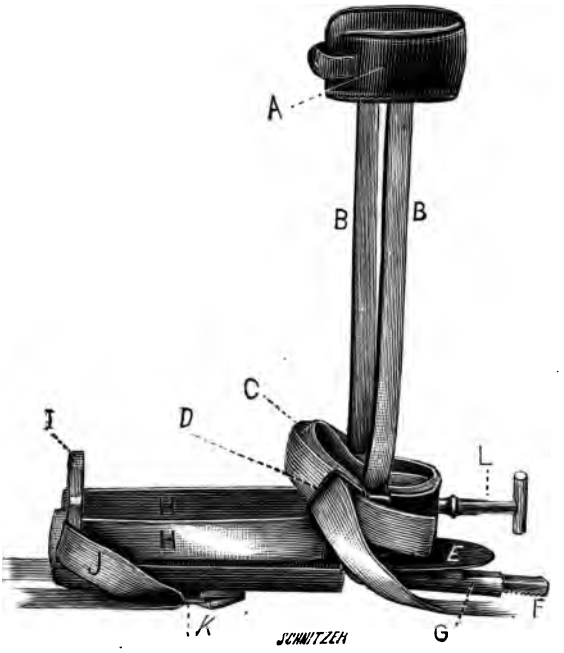

FIG. 16.

Adapting the antero-posterior traction apparatus exactly to the antero-posterior deformity by using key L, Fig. 16, and placing the foot, with its traction heel-strap and astragalar pad adjusted as in Fig. 14, in the apparatus, we have an adjustment as shown in Fig. 17. The astragalar strap, A, is buckled on itself, holding the foot securely in the heel-cup; the traction heel-strap, B C, is drawn tightly, reflected back around the vertical uprights of the "bridge," and buckled, each one of these webbing straps being made as

tense as possible. The apparatus fits the deformity and the heel is squarely in its place, being retained by the astragalus

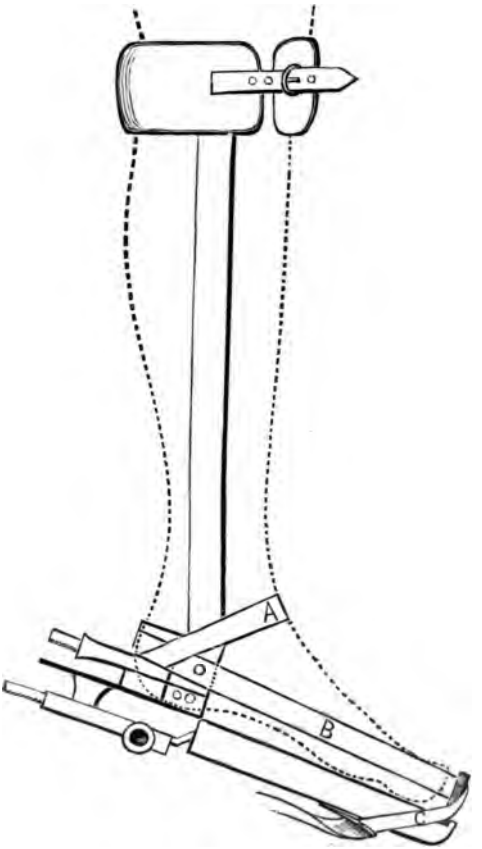

FIG. 17.

strap. The astragalus strap, A, is made very tight in order to get an accurate and tense adjustment of the traction heel-

strap, B C. Being sure that B C is drawn tightly, with the heel well down, and resting against the posterior part of the heel-cup, we now *loosen the astragalar strap*, A, *from half an inch to an inch and a half*, depending on the size of the foot.

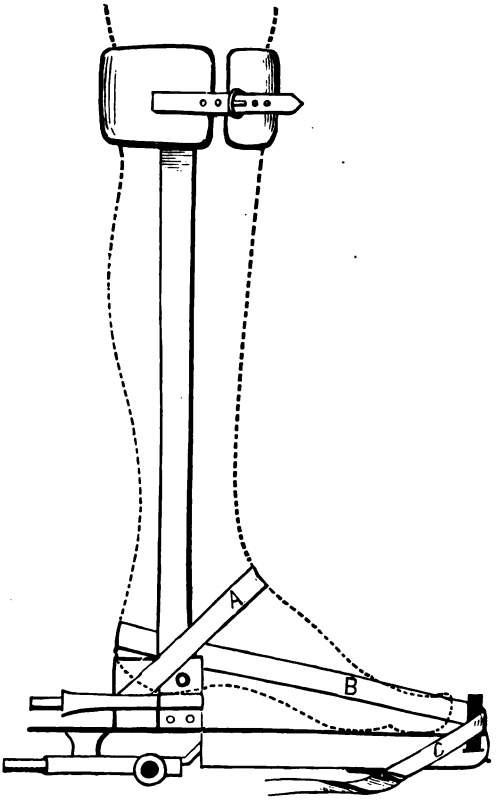

FIG. 18.

All being ready, we now use the key A (Fig. 10), and change the position of the apparatus from extension to that of the

right-angled position. What happens? The apparatus obeys, but the foot does not change its position; the loosened astragalus strap allows the heel to take its own position, and no traction is made upon the resisting tissues.

Fig. 18 shows this result. The foot-plate of the apparatus is at the right-angled position, but the post-tibial contractions are unaffected. There has been nothing done to bring the heel *downward* and *forward*. On the contrary, it has remained in its original position, because the force thus far used has been applied upon the incorrect principle shown in Fig. 6.

We now give the key A (Fig. 10) another turn or two, and use the antero-posterior worm and screw to force the apparatus into the position of flexion. The heel still remains in its original position. Now, however, use key C (Fig. 10) and apply direct traction. The result is shown in Fig. 19. The heel is drawn irresistibly *downward* and *forward*, the toes are carried *upward* and *forward*, and the *loosened astragalus strap permits the neck of the astragalus to move upward and backward.* By this simple process we have given the apparatus the desired plane of flexion, have made full allowance for the rotating astragalar neck, and have deliberately drawn the resisting foot into the position sought for, and fulfilled the indications presented in Figs. 4 and 5.

It will be noted not only that the normal antero-posterior movements of the ankle joint are here reproduced, but that they are *exaggerated.* We can, by the use of this apparatus, imitate the natural movements, and, by the use of traction, stretch all the opposing antero-posterior tissues, whether post-tibial or plantar, or both. It not infrequently happens that the adolescent foot is permanently elongated half an inch by this easily controlled traction-force without tenotomy, and a temporary gain of from one eighth to one

fourth of an inch at a single treatment, lasting only fifteen or twenty minutes, is not unusual. This makes this appa-

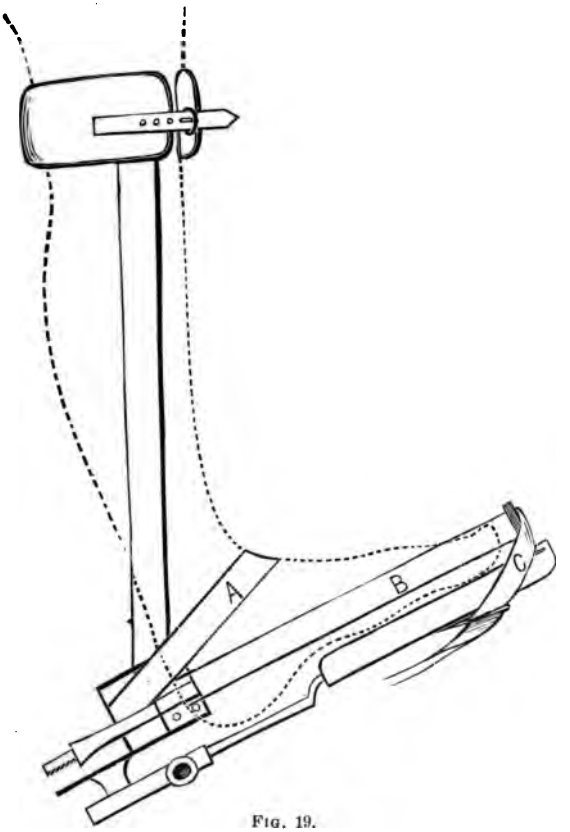

FIG. 19.

ratus particularly serviceable in adult or adolescent cases of non-deforming club-foot,* as well as in confirmed talipes equinus.

* See "Non-deforming Club-Foot," by the writer, "Medical Record," May 23, 1885.

We can make this traction apparatus available also in the, strictly speaking, tarsal or plantar contractions, espe-

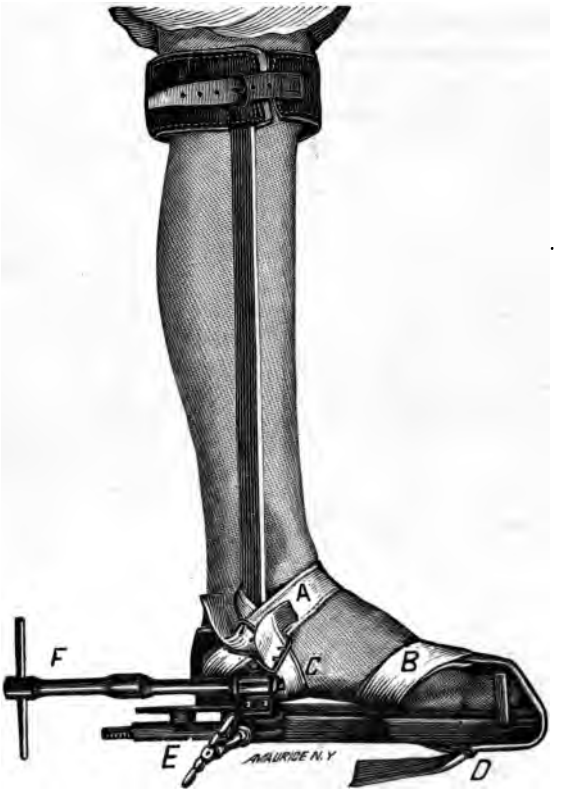

FIG. 20.

cially when they are antero-posterior. When much varus exists, the "lateral-traction shoe" is indicated, and this will be described further on.

In Fig. 20 the antero-posterior traction-shoe is applied

to a patient with marked contraction of the plantar fascia. The astragalar strap is fastened in the manner described at Fig. 16. In place of the traction heel-strap there described, however, a webbing strap (C, Fig. 20) is passed underneath the os calcis and behind the lateral uprights of the apparatus, "buckling on itself," as does the astragalus strap (A, Fig. 20). We then have the os calcis secured firmly in the heel-cup by the astragalar and sub-os-calcis straps. A loop of webbing is then passed over the anterior part of the foot, just back of the "ball of the foot" (B, Fig. 20), and this is fastened to a buckle on the under part of the footplate (D, Fig. 20). The apparatus is now placed in any desired position of flexion, and direct traction is applied with key E, Fig. 20, and the result is shown in Fig. 21.

The more firmly the astragalus and the os calcis are fixed, the better in this condition, as the traction is needed at the plantar fascia, and not at the gastrocnemius muscle, and hence the astragalus strap is not loosened, as in the treatment of post-tibial contractions. I have seen severe and apparently permanent contractures in the adult overcome without tenotomy by this simple method of treatment, and it is apparently an easy matter to lengthen the foot from one eighth to one half of an inch in adults and adolescents by the traction method in cases of plantar contracture.*

Let us now briefly study the conditions found in equinovarus, and attempt to demonstrate some of the mechanical points involved, before describing the "lateral-traction shoe."

As before stated, I formerly used the simple "lateral

* In Figs. 20 and 21 the necessary pads over the astragalus and under the metatarsal loop are omitted in order to show the principle of action more clearly. No pad is needed under the os-calcis strap.

pusher" in treating the lateral malpositions of equino-varus, and I reproduce the original engraving that was used in my

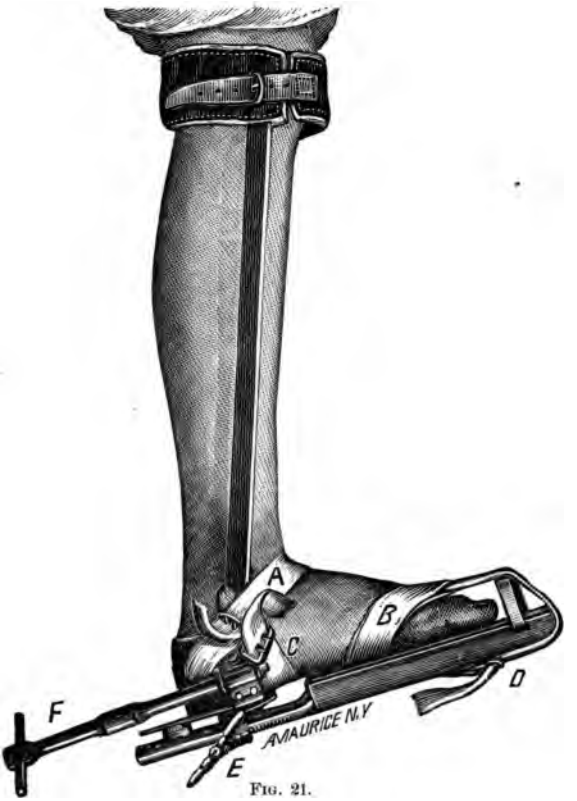

FIG. 21.

first paper on "Traction." It is shown in Fig. 22. Applied to the inner side of the foot and leg, it was intended to overcome the lateral deformities of equino-varus by a *pushing* force. It is, so far as I know, the only apparatus based

upon the, strictly speaking, *pushing* principle (acting from a point above the tarsus) introduced for the treatment of the lateral deformities of talipes, though I inadvertently described it in my first essay as a "modification of Taylor's ankle support." In the "Hospital Gazette and Archives of Clinical Surgery" for January 9, 1879, about seven weeks after my first article appeared, I called attention to my error, and claimed the apparatus as my own.

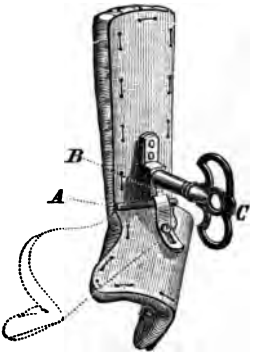

FIG. 22.

After a good deal of experience with this simple "pusher," I felt that it represented a correct principle of mechanical treatment, and that a lateral *pushing* force possessed many advantages over the lateral *pulling* force ordinarily employed. And, after many experiments, I have at last perfected a lateral *pushing* and *traction* apparatus, which enables the operator to apply a positive traction force to the deformity known as equino-varus.

But this term *equino-varus* is really a misnomer. There is some equinus present, for the heel is raised. There is some varus present, for the tarsus is turned in. If these conditions were all that marked the deformity known as equino-varus, the artificial mechanism devised for its relief need not be very comprehensive. But simple, uncomplicated equino-varus is rare in my experience.

Fig. 23 represents a sectional outline (reduced) of the normal (right) ankle of a boy of eight years. A represents the outer malleolus, B the inner malleolus. The line C D E passes through the ankle joint to the heel, E, D representing,

without being passed under the retaining bandage, as in Fig. 14. It is carried forward to the uprights of the bridge and is reflected back at O, to pass, as in J (Fig. 16), to the buckles underneath the foot-plate.

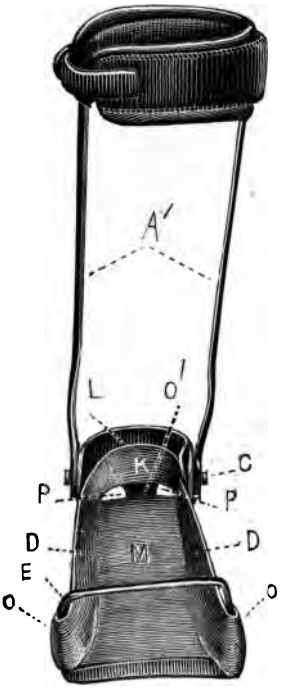

FIG. 15.

In Fig. 16 the astragalus and heel traction-straps are shown in position, the general adjustment being illustrated in Figs. 17, 18, and 19. The astragalus-strap, C, is made of Allien's webbing, five eighths of an inch wide, seventeen or eighteen inches long, and a buckle is sewed on one of its free ends, as at D (Fig. 16). This webbing is passed through the openings in the upright part of the heel-cup (M M, Fig. 12), and is "buckled on itself," as shown in the engraving. The traction heel-strap is also shown (H J), though, of course, this strap is passed around the heel and under the retaining bandage as a preliminary step, as shown in Fig. 14.

I have made it a cardinal rule in the treatment of chronic deformities *to make the apparatus fit the deformity*, and to so arrange the mechanism of the apparatus that a progressive and easily applied pressure may be exerted in the direction indicated. This is especially true of the mechanical treatment of club-foot, and I have long since ceased to at-

tempt to crowd a crooked foot, partly relieved by tenotomy, into, comparatively speaking, a straight apparatus.

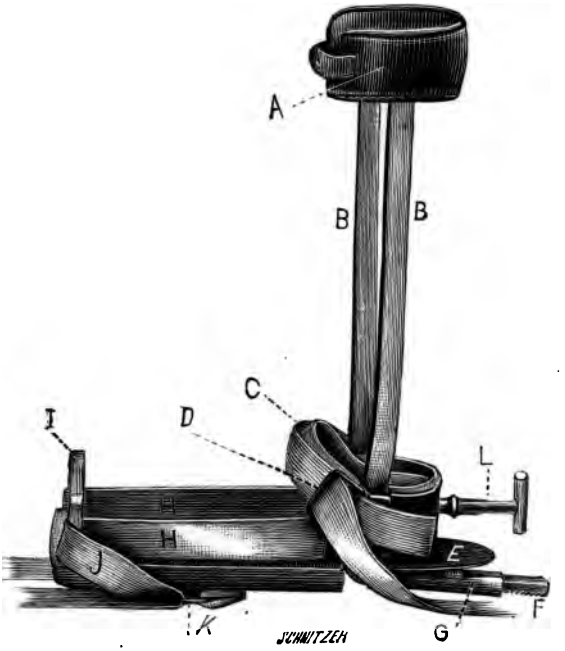

FIG. 16.

Adapting the antero-posterior traction apparatus exactly to the antero-posterior deformity by using key L, Fig. 16, and placing the foot, with its traction heel-strap and astragalar pad adjusted as in Fig. 14, in the apparatus, we have an adjustment as shown in Fig. 17. The astragalar strap, A, is buckled on itself, holding the foot securely in the heel-cup; the traction heel-strap, B C, is drawn tightly, reflected back around the vertical uprights of the "bridge," and buckled, each one of these webbing straps being made as

shown by combining these two diagrams in one. And this has been done in Fig. 27. Using the heel as a fixed point,

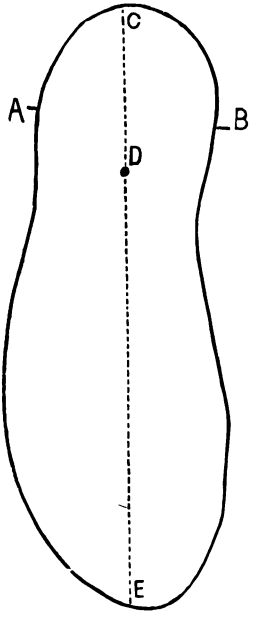

FIG. 25.

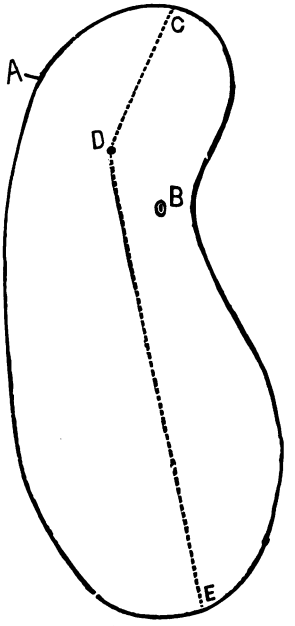

FIG. 26.

the effort should be made to throw the anterior part of the foot in the direction of the curved arrow, G H, until the normal position, or an exaggeration of the normal position, is reached. When this is done, the two malleoli will be found in their proper positions as shown in the diagram (Fig. 27); the rotation of the astragalus and the anterior part of the tarsus upon a vertical axis will be overcome, and the leg and thigh will be found to occupy a normal relation to the tarsus.

In equino-varus (I speak especially of the congenital

strap, B C. Being sure that B C is drawn tightly, with the heel well down, and resting against the posterior part of the heel-cup, we now *loosen the astragalar strap*, A, *from half an inch to an inch and a half*, depending on the size of the foot.

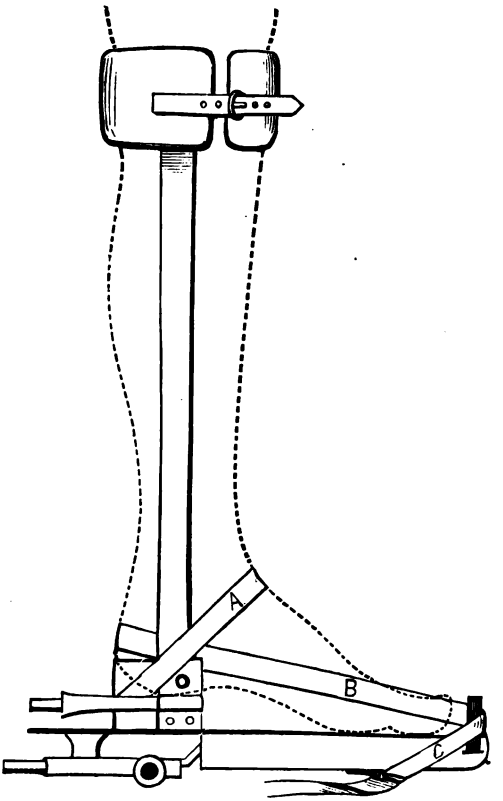

FIG. 18.

All being ready, we now use the key A (Fig. 10), and change the position of the apparatus from extension to that of the

right-angled position. What happens? The apparatus obeys, but the foot does not change its position; the loosened astragalus strap allows the heel to take its own position, and no traction is made upon the resisting tissues.

Fig. 18 shows this result. The foot-plate of the apparatus is at the right-angled position, but the post-tibial contractions are unaffected. There has been nothing done to bring the heel *downward* and *forward*. On the contrary, it has remained in its original position, because the force thus far used has been applied upon the incorrect principle shown in Fig. 6.

We now give the key A (Fig. 10) another turn or two, and use the antero-posterior worm and screw to force the apparatus into the position of flexion. The heel still remains in its original position. Now, however, use key C (Fig. 10) and apply direct traction. The result is shown in Fig. 19. The heel is drawn irresistibly *downward* and *forward*, the toes are carried *upward* and *forward*, and the *loosened astragalus strap permits the neck of the astragalus to move upward and backward.* By this simple process we have given the apparatus the desired plane of flexion, have made full allowance for the rotating astragalar neck, and have deliberately drawn the resisting foot into the position sought for, and fulfilled the indications presented in Figs. 4 and 5.

It will be noted not only that the normal antero-posterior movements of the ankle joint are here reproduced, but that they are *exaggerated.* We can, by the use of this apparatus, imitate the natural movements, and, by the use of traction, stretch all the opposing antero-posterior tissues, whether post-tibial or plantar, or both. It not infrequently happens that the adolescent foot is permanently elongated half an inch by this easily controlled traction-force without tenotomy, and a temporary gain of from one eighth to one

The first indication, from a mechanical standpoint, in the treatment of equino-varus is to overcome the inversion of the os calcis (see Fig. 24) so that a fixed point may be secured upon which to apply a rotating traction force in the direction indicated in Fig. 27. The curved arrow, I K L H, of Fig. 24 shows how this force should be applied, and a glance is sufficient to show that a *pushing* force, purely lateral, is indicated. The hinged lever and screw of the simple lateral pusher (Fig. 22) meets this indication perfectly.

The second indication is to find a center of motion (the first lateral push having been applied to the os calcis) which will permit the application of a traction force that will remove the rotation of the astragalus and carry the anterior portion of the tarsus with it. The direction of this force should be *forward* and *outward*, and a study of Fig. 28 will demonstrate that this center is at a point located at or outside of the outer border of the foot in the region of the articulation of the os calcis with the cuboid bone. This point is indicated at the letter C (Fig. 28), and the curved arrow, I P E F G H J, gives the direction required, viz., forward and outward. This is the second indication.

But the heel is raised, and, unless this malposition can be removed, the lateral push to the os calcis and the rotat-

very limited movements in the direction of their exaggerated, deformed position.

It seems to me that both these and other allied conditions are due primarily to unilateral muscular action of the nature of a contracture or a localized arrest of muscular development, and that the exaggerated position of these small bones, their rotation, the contracture of ligaments, fasciæ, skin, and all the subcutaneous tissues, are the result of *rapid growth* in the acquired position. In no other way can I explain the exaggerated rotation, and the other phenomena observed.

ing (traction) force applied to the tarsus will amount to little or nothing.

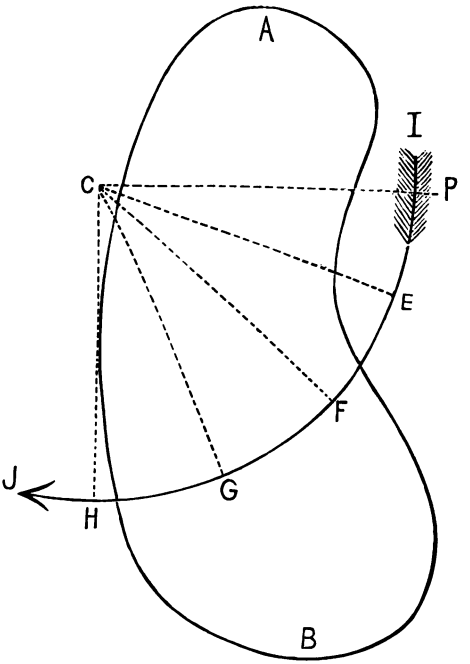

FIG. 28.

As demonstrated in the first part of this paper, the heel should pass *downward* and *forward*. By attaching the heel traction strap to the traction rod which carries the anterior part of the apparatus *forward* and *outward* upon the center C (Fig. 28), this movement may be readily accomplished. This is the third indication.

While it is necessary to restrain the astragalus by an astragalar strap, the same as in the antero-posterior traction-shoe, in order to execute all these movements—viz., the

lateral push, the rotating push, and the direct traction—the movement of the apparatus when applied to the conditions of equino-varus concentrates the counter-pressure at the dorsal portion of the articulation between the os calcis and the cuboid, and the acquired position of the apparatus, when all these three movements have been applied, represents the exact reverse of the deformity. In short, as in the antero-posterior traction-shoe, the apparatus being applied exactly to the deformity, the foot is forcibly drawn into a reverse position by means of a direct rotating traction, and all the resisting tissues are reached, including the ligaments and fasciæ as well as the muscles.

The lateral-traction apparatus is based upon these three indications (the three varieties of rotation mentioned above), and I will now describe it in detail.

It consists (Fig. 29) of a calf band, A, to which is attached a single upright of annealed steel, A^1. This upright is always placed on the side toward which the deformity looks; in varus on the inside, in valgus on the outside of the leg, the instrument being a *pusher*. At a point just above the center of motion of the ankle joint is placed a *lateral joint*, C, which is acted upon by a hinged lever and screw; B^2, being a worm and screw, and O an arm which pushes the lower part of the apparatus toward the deformity to any desired extent. The distal end of this arm is free, and, as the arm is turned away from the deformity by key B^1, the foot part of the apparatus takes any lateral position required. All of the keys—B^1, E^1, and G^1—are removed, of course, after the desired lateral position is obtained and traction has been applied.

This lateral hinge, with its lever and screw, is intended to meet especially the inversion of the os calcis. It antagonizes, when traction is applied, the tibialis posticus muscle contraction as well as the shortening of the internal

lateral ligament, which is frequently more troublesome than the muscular contraction. This first lateral push is important and essential.

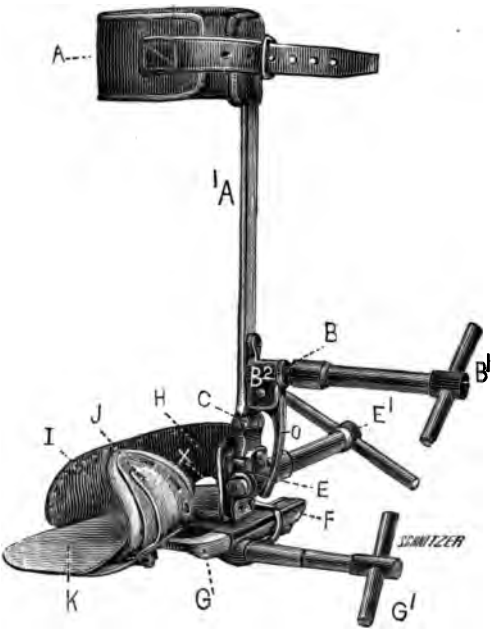

FIG. 29.

Just below this hinged lever and screw is an antero-posterior joint, E, similar in all respects to that used in the antero-posterior traction apparatus described in the previous pages. It is a simple worm and screw controlled by the key E¹. Like the worm and screw in the antero-posterior apparatus, it enables the operator to secure any desired angle of flexion and extension, and to create a plane different from that of the deformity. The traction executed by

this apparatus, like that in the apparatus first described, draws the foot into this acquired plane and stretches all the resisting tissues.

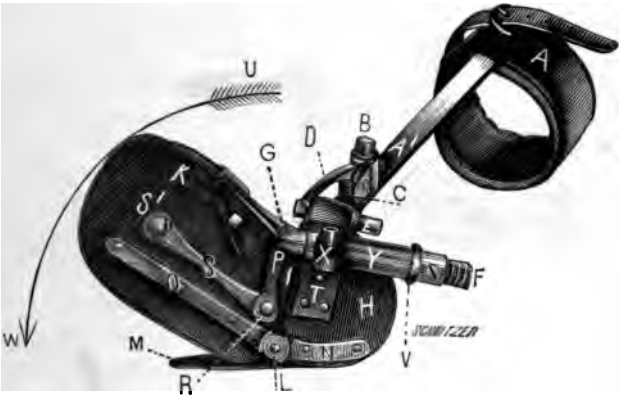

FIG. 30.

Still lower and acting upon the anterior part of the foot-plate (which is divided transversely at a point correspond-

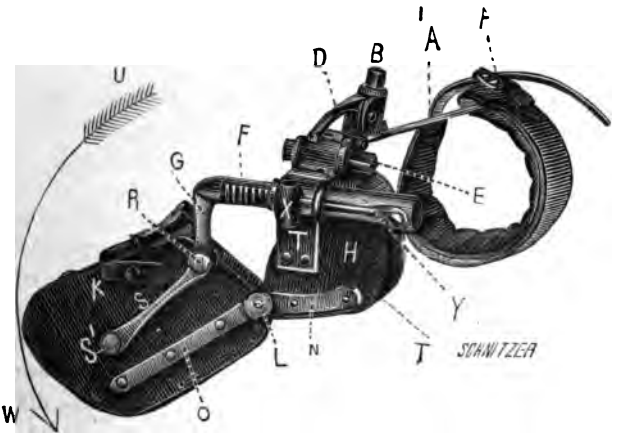

FIG. 31.

ing with the medio-tarsal joint) is the traction rod placed upon the inner side of the apparatus and moving in the cylinder F. It is controlled by the key G^1. This will be more fully dwelt upon when we study the under surface of the foot-plate.

There is the customary heel-cup (though this is not necessary any more than in the antero-posterior apparatus, X, Fig. 29, and H, Fig. 32) with the openings (K K, Fig. 32) through which the restraining astragalus strap is passed. The outer part of this heel-plate (M, Fig. 30; L, Fig. 32; and I, Fig. 33) is extended quite well forward at the outer border of the foot-piece to form a resistance to the rotating movement imparted to the foot by the traction rod G upon the center L. And the inner border of the foot plate is curved over the dorsum of the foot (J, Fig. 32) in order to grasp it as it moves upon the center of motion at the outer border of the foot, as shown in Figs. 30 and 31, L. The heel-plate part of the heel-cup has the semicircular opening (P, Fig. 32) to permit the descent of the heel when the traction is applied, the same as in the antero-posterior shoe.

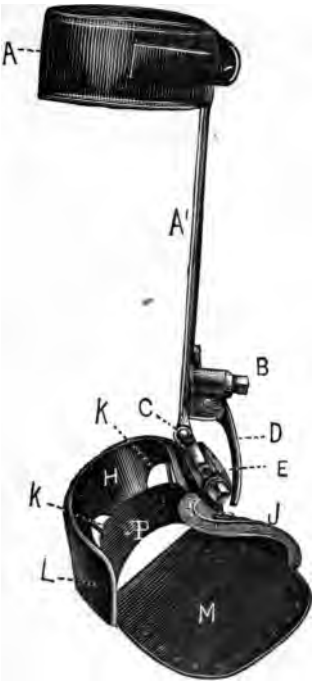

FIG. 32.

Figs. 30 and 31 show the lower surface of the foot-plate. In the former the traction rod is closed in the position of deformity; in the latter it is extended or thrown open, showing by the arrow, U W, the direction of the force applied, viz., *forward* and *outward* (compare with Fig. 28). At K, Figs. 30 and 31, is an arrangement by which the curved part of the foot-plate (J, Figs. 29 and 32) can be adapted to any position required.

Fig. 32 pictures the apparatus in a position of slight equino-varus. The lateral hinged lever and screw has been turned to meet the inversion of the heel. The antero-posterior worm and screw has been used to drop the foot into a position of equinus, and the traction rod is closed in a position of varus. By using the three movements described as being controlled by keys B^1, E^1, and G^1, in Fig. 29, a direct antagonizing traction force can be applied to almost any degree of deformity of the equino-varus type.

In Fig. 33 the astragalus strap, M, is shown. (The artist has made this webbing strap fully one half too wide.) It is passed through the openings in the heel-plate K K, Fig. 32, and is reflected upon itself and buckled.

The foot is prepared for this apparatus as pictured in Fig. 14. A soft pad of Canton flannel or other soft material is placed over the neck of the astragalus under a simple retaining bandage, and a traction heel-strap, with, however, a buckle attached to one end, is passed around the heel low down and the ends brought forward. The foot is now placed in the apparatus, which is made to exactly fit the deformity. The astragalar strap (M, Fig. 33) is then buckled tightly and the heel traction strap, not lettered in Fig. 14. is brought directly down, inside the heel-cup, and buckled underneath the foot-plate just anterior to the right-angled bar, P, of traction rod F (Fig. 30). This traction heel-strap is buckled tightly. (It seemed impossible to show this trac-

tion heel-strap in the engraving.) The astragalus strap (M, Fig. 33) is now loosened slightly to accommodate the upward movement of the astragalus when the ankle is forcibly

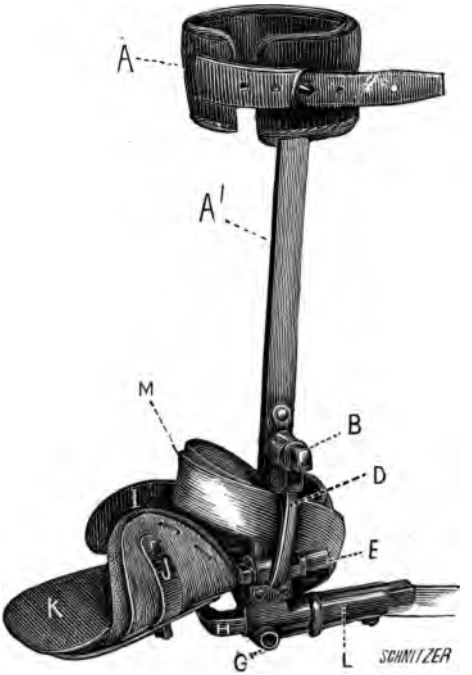

FIG. 33.

flexed. All being in readiness, key B^1 (Fig. 29) is used to turn the hinged lever and screw which everts the os calcis. Key E^1 (Fig. 29) is then used to raise the foot-plate to the desired extent toward or above the right-angled position. When these two movements are satisfactorily executed, key G^1 is made to turn the foot-plate outward and forward upon the center (C, Fig. 28, and as in Figs. 30 and 31), into a valgus position, the traction heel-strap drawing the heel

downward and *forward* as in the antero-posterior traction apparatus, while the anterior portion of the tarsus is rotated *outward*. All the movements indicated are accurately fulfilled. The traction heel-strap is especially necessary to carry the heel downward and forward, while the tarsus is being thrown forward and outward by the traction rod. If the heel is not controlled in this manner, the lateral rotating traction is rendered useless.

The location of the center of motion at the outer border of the foot-plate must be determined by the degree of lateral deformity. I have for years placed it at different points; at the very edge as in the engravings, or farther out or back, as the case demanded.

Having described briefly the two forms of apparatus used to obtain traction, I may now speak somewhat in detail regarding their use in practice, and refer to the rules which should govern the employment of the traction.

When we have to deal with the confirmed deformity of especially congenital equino-varus, it must be apparent that, in order to remove the malposition, the force applied should exceed the resistance. No one, I think, would maintain that the skin and subcutaneous tissues could tolerate a force of this nature for any considerable length of time. And experience proves that this is not necessary.

In a lecture on "Knock-knee and Bow-legs," delivered by me in 1879 and published in the "American Journal of Obstetrics and Diseases of Women and Children" (July, 1881), I called attention to the fact that the superficial tissues would tolerate a greatly exaggerated pressure for a few seconds or even moments without any unpleasant consequences, and I made this fact the basis for the mechanical treatment of the conditions there described. And this is the basis of the "Treatment of Club-foot by Traction," whether tenotomy is used or not.

The manner in which the traction apparatus should be used may be briefly described.

The first step is to adjust the apparatus, whether the antero-posterior or lateral, so that *it will exactly fit the deformity.* Then apply the heel traction and astragalus retention straps as described in Fig. 14, and secure the foot firmly in the heel-cup of the apparatus by buckling the astragalus and heel-traction straps. Apply a moderate amount of traction at first, always being sure that the astragalus retention strap is loosened (after the heel-traction strap has been made tense) to permit the upward movement of the astragalus when the ankle is drawn into flexion. Determine at the first application how much traction can be tolerated by the patient without causing pain. Proceed easily and gently at first, and after a few interviews the pressure may be increased to the desired extent without any difficulty or trouble.

After the patient is accustomed to the apparatus, keep the traction-shoe applied most of the time, using gentle traction at first, and removing the apparatus only when the patient goes out of doors for necessary exercise, or at night, when in both instances the proper passive, or retention, support is worn. When this point is gained, commence a systematic application of the momentarily exaggerated traction.

My method is to apply the exaggerated traction at intervals of one half hour or hour for the period of toleration, be it five seconds or five minutes. During the intermission little or no pressure is used, and the patient walks about with the traction shoe applied. Experience proves that what is gained during these seconds or minutes of exaggerated traction is not lost during the intermission, and a frequent repetition of "intermittent treatment" will be followed, as a rule, by a lengthening of the foot, showing

that the plantar tissues are yielding; a visible lengthening of the gastrocnemius muscle soon becomes apparent, and the deformity yields to the traction.

Always insist upon careful attention and intelligent home care, and always see the patient once a day for the first few days, after which, in many cases, the mother or nurse can carry out the treatment at home, with occasional visits from the surgeon.

Under these circumstances, and with the use of proper prophylactic measures, as applied to the skin and subcutaneous tissues, excoriations will not occur. In private practice I have never seen any excoriations that interfered with progressive treatment, and in no case have I seen even slight excoriations, except as the result of neglect on the part of the attendant. The traction is tolerated well, the tissues yield, the deformity grows less marked, the muscles increase in circumference, as well as in length, under the influence of the traction, and in very many cases the knife will be unnecessary. We can, in short, restore the muscles and fasciæ, as well as the ligaments, to their normal length, and the ultimate result is a foot more nearly approximating the normal than any which I have ever seen after the usual procedure of tenotomy.

But there are some cases which do not readily yield to traction alone. They are not common, but when they occur it is an easy matter to perform tenotomy and remove the element of muscular resistance. But the patients upon whom tenotomy has been performed complain of pain much more than do those who have been treated by simple traction. In by far the greater majority of cases the pain inflicted by properly applied traction is so slight that neither the patients nor their parents complain. Adolescents and adults bear it without any complaint whatever.

I know of no rule by which any one can determine

LAKE LOGAN

whether a given case will yield to traction, or whether it will require both tenotomy and traction. It will be a very exceptional case that does not yield to the two combined. My rule is to apply traction first, and, if it fails after a fair trial, to perform tenotomy also. And I know of no apparatus that answers so good a purpose after tenotomy as these traction-shoes. They are readily adjusted, easily applied, and the force can be regulated to any degree of indicated pressure. If tenotomy has been performed, I make a vigorous traction while the patient is still under ether, and gain all I can while the patient is still unconscious. I have even proposed to place a patient under ether and make vigorous traction without tenotomy as a substitute for this operation. But I have not done this yet. The apparatus can be made to exert a great degree of force, and I think I can say that both the antero-posterior and the lateral apparatus are constructed upon correct mechanical principles. Certainly the results obtained by their use warrant me in saying that the prediction I made nine years ago, that the use of traction would "make the necessity for tenotomy much less frequent," has been fulfilled.

I do not oppose tenotomy when necessary. I prefer, as the result is so much better, to obtain the result with traction alone if possible, even if a longer time is taken to produce it. The elongated, freely moving, and symmetrical foot obtained by traction more than compensates for the apparent loss of time. And I have seen no relapse after the tissues are once elongated by traction, as there frequently is after tenotomy.

I have had some failures with this apparatus, without tensotomy, just as I have had many successes. But I am very certain that most, if not all, of the former were due to causes beyond the control of the surgeon, just as I am equally certain that many cases, both among adolescents

and children, which have been condemned to tenotomy or even osteotomy by prominent surgeons, have been absolutely restored without operative measures by simple traction, intelligently and perseveringly applied.

In conclusion, I wish to tender my thanks to Dr. Samuel Ketch, of New York, and Dr. A. Sydney Roberts, of Philadelphia, for their courtesy in calling attention to my apparatus in articles recently published by them.

LANE MEDICAL LIBRARY

To avoid fine, this book should be returned on
or before the date last stamped below.

[redacted]

M783
S52
1887

Shaffer, N. M. 16535
The use of traction
in the treatment of
club-foot...

DATE DUE